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ABSTRACT

Further generations of children will be more dependent on science and technology than any generation before them. There is an urgency to insure that they will be able to survive in a highly technological setting. This will occur only with the help of teachers, parents, scientists, engineers, and others in the community. This document provides guidelines to help teachers form partnerships with scientists and engineers. Tips are provided regarding choosing the most appropriate speakers, making contact with them, cooperative planning between the scientist and/or engineer and teachers, and classroom discussions and activities after the visit. (ZWH)

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ED 406 135

Sharing Science:

Linking Students with Scientists and Engineers

A Survival Guide for Teachers

The Task . . .

Students learning science can experience the excitement of discovery and invention. Understanding science prepares them to participate in an increasingly complex and competitive scientific and technological world.

Meeting the challenge of teaching our children in this rapidly changing world is not easy. Teachers have limited time and materials for teaching science and often find themselves teaching without access to the real world experiences that can make science come alive.

One of the best allies any teacher can have is a person who knows and understands science. A scientist or engineer can help students:

- experience the excitement of discovery and invention
- develop an informed approach to the role of science and technology in our world
- observe teachers and scientists working together as partners
- associate science with a real human being
- see the personal rewards of scientific and technical careers
- realize that women and minorities can pursue careers in these fields

Every community is home to a variety of science professionals who are concerned, just as you are, about educating tomorrow's citizens. Across the nation thousands of them have demonstrated their willingness and ability to become involved in our schools. This guide provides suggestions to help you collaborate successfully with scientists and engineers in your classroom and to make the experience a success for you, for your students, and for those who volunteer to share science with you.

Now —
Get ready!
Get set!
Go!

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GET READY!

- **Think creatively about what you want to accomplish.**

  Look for opportunities for your students to get to know a real scientist as an interesting person. Encourage scientists to share the excitement of discovery and enthusiasm for their professions. Cultivate student interests and questions through new experiences, ideas and information.

- **Identify a scientist, engineer, or a science user.**

  Many school systems have formed active partnerships with science centers, science alliances, scientific societies and local universities. Corporations and business groups are interested in volunteering in the classroom. Ask your system or state science coordinator for help in contacting local scientists. It may be easier than you think.

- **Make contact well in advance.**

  Remember, it will take time to develop a plan. Your volunteer has a busy schedule, too, so be flexible. Find out when and how each of you prefers to be contacted. Provide backup phone numbers in case a change in plans makes last minute contact necessary.

- **Decide together what to do.**

  Have a conversation with your volunteer about what she can do to help you enrich your science program. Explore with her what experiences, activities, information would be of interest to your students and appropriate to your curriculum. Agree on one or more activities which engage your students.

GET SET!

A month or so in advance:

- **Schedule and determine the setting for the activity.**
  Will the scientist work with your whole class or with small groups? Will the activity be indoors or out? Agree on the time allotted for the activity. Allow for flexibility!

- **Identify any special equipment or space that is needed.**
  This could include laboratory equipment, A-V materials, flat tables, electrical outlets, water, or scissors. Agree on how materials and equipment will be managed to ensure both safety and efficiency.

- **Give the scientist a profile of your students.**
  Let him know the number, age, learning characteristics, and special needs of your group. Tell the volunteer what your students have been studying and how the proposed activity will fit in.

- **Provide directions to the school and parking information.**
  Tell the scientist where and how she will be greeted.

A few days before the visit:

- **Call the volunteer to confirm your plans.**

- **Prepare a welcome.**
  Select a team of several students to greet the volunteer and help with any equipment which may need to be carried in.

- **Prepare your students.**
  Explain who their guest is and what he will be doing. Review rules of courtesy. Prepare name tags so the scientist can call on students by name. If students will be working in groups, assign them ahead of time.

"I have no children of my own; I have never had a teacher education course; and I have never taught either grade school or high school before in my life. Consequently, I was a bit apprehensive about the whole thing. However, you put me at ease, and your class was a model of attentiveness and good behavior. I found your students to be a joy to teach. If ever you feel like taking a chance with me again, I'd love to come and teach your class a second time."

—Dr. David M. DeMarini,
Research Genetic Toxicologist

"I...discussed basic principles of electricity and magnetism and helped students make simple circuits. Students enjoyed the "hands-on" experience. Based on past experience, I expected iron filings and small compasses to be available. I should have reviewed the list of materials with the teacher ahead of time."

—William M. Yeager, Ph.D.,

GO!

On the day of the visit:

- **Be sure students, equipment, and space are ready.**
- **Have your welcome team meet your visitor.**
- **Introduce the visitor to your class.**
- **Remain actively involved during the visit.**
  Show your students that teachers are learners, too. When you are interested, students will follow your example. Be a second pair of adult hands if needed. Lend your quiet expertise in classroom management.
- **Understand what your students are learning.**

After the visit:

- **Extend appreciation.**
  Thank-you notes, drawings, or photographs from students are always appreciated. Scientists especially like to know what students learned and what interested them.
- **Provide feedback about the activity to the scientist.**
  Scientists are learners, too. They will respond to your positive reinforcement as well as constructive criticism.
- **Follow up**
  Discuss with your students what they learned and what else they want to know. Build on their experience with follow up activities. Incorporate interdisciplinary activities in writing, spelling, art, social studies, reading, and math. Complete any experiments left by the visitor and let her know the results.
- **Share your experience with parents and colleagues as well as school administrators.**
- **Plan for more visitors.**
  Make your experiences diverse. Invite people with different backgrounds, women and men, minorities, and people with disabilities.

"Like the children we teach, we learn as a result of our own activity—our own struggle to make sense of what we see....We are in this classroom together, and this science work will only be exciting if we care about it together. If I say 'Scientists are curious,' but I am not showing curiosity, children will perceive this inconsistency. I need to show, as well as say, how that looks."

—Ellen Doris, Northeast Foundation for Children, "Doing What Scientists Do"

"More than twenty "Thank-You" cards made by these students with their own words of personal appreciation were sent to me. This was certainly unexpected but was definitely a thrill for me to see the creativity of these students, of how they conceived the microbes and me and then expressed it in pictorial illustrations."

—Joseph K. Li, Pharmacologist

We Are All Scientists!

Children and scientists have much in common. Naturally inquisitive, young children ask endless questions. They may spend half an hour watching a bug crawl on the floor. Children sort money, pictures, toys, shells, pasta shapes, and words. They experiment by pouring water into soil, mixing different colors of paints, or adding blocks to a tower until it falls. They draw conclusions about the way things work. They learn from and share information with others.

Scientists share with children a natural curiosity about the world. They are trained to use a more systematic and sophisticated approach to inquiry than children do. They have developed the discipline to remain objective, to reserve judgment until they have the facts, and to recognize the limits of their knowledge. Nevertheless, the skills used in doing science are the same — whether you're a student or a scientist!

Science Process Skill	Children	Scientists
observe	look, touch, smell, taste, listen	microscope, x-rays, chromatography, seismograph
experiment	change something and watch what happens	change and control variables
collaborate	partners in classroom	colleagues around world
record	journal, score card	field notes, computer
measure	scale, ruler, stopwatch measuring cup	computer analysis, calibrated apparatus
sort and classify	color, size, shape, weight	taxonomic key, relevant functional groupings
compare	fastest, largest, farthest	change over time, change in differing conditions
analyze	what happens most	statistical analysis
share information	class meeting; at recess, "Guess what I found out?"	scientific meetings, E-mail; over coffee, "Guess what I found out!"

Science in the Classroom

Listed below are suggestions of people who might be able to help you in the classroom. Some are research scientists. Others use science in their everyday work life. Other people who might be helpful are hobbyists and collectors who study weather, plants, animals, astronomy, rocks and minerals, or fossils.

Animals	Zoologist, entomologist, microbiologist, marine biologist, paleontologist, cytologist, physiologist, chemist, ecologist, neurobiologist, geneticist, anatomist, mammalogist, limnologist, pharmacologist	Zookeeper, veterinarian, beekeeper, animal trainer, physician, forest ranger, wildlife manager, farmer, rancher, audiologist, nurse, dietician, X-ray technician, forensic specialist, pharmacist
Plants	Botanist, paleobotanist, agronomist, agricultural chemist, ecologist, geneticist, paleontologist, pathologist, soil scientist	Horticulturist, farmer, forest manager, nutritionist, landscape architect, soil conservation officer, park ranger, agricultural extension agent
Weather	Meteorologist, ecologist, agronomist, geologist, oceanographer, climatologist	TV weather forecaster, airport flight controller, fisherman, boat captain, farmer, pilot, environmentalist, soil and water conservation agent
Physical & Chemical Properties	Chemist, biochemist, pharmacologist, molecular biologist, physicist, ecologist, toxicologist, metallurgist, geologist, forensic criminologist, materials scientist, engineers: chemical, textile, industrial, acoustical, optical, mechanical, civil, nuclear, agricultural, and ceramic	Architect, inventor, mechanic, carpenter, musical instrument maker, musician, photographer, builder, police lab technician, water company technician, cosmetics developer, gemologist, building inspector, potter
Electricity & Magnetism	Physicist, geologist, computer hardware/software designer, engineers: industrial, electrical, thermal, mechanical, and electronic	Electrician, radar technician, amateur radio operator, telephone system maintenance technician, electrical inspector, inventor, radio/TV engineer
Earth & Space Science	Astronomer, geologist, paleontologist, ecologist, physicist, biologist, chemist, vulcanologist, seismologist, oceanographer, soil scientist, engineers: aeronautical, aviation, construction, and civil	Pilot, astronaut, geographer, cartographer, surveyor, geotechnical tester, aerial photographer
Behavioral & Social Science	Animal psychologist, clinical psychologist, psychiatrist, sociologist, anthropologist, historian, archaeologist, geographer, demographer	Marketing professional, business manager, city planner, applied economist, school psychologist, pollster, market research analyst, statistician

How Scientists Can Help You

Scientists, engineers, and people who use science in daily life can:

- Demonstrate scientific concepts and direct applications of science and technology
- Develop experiments and do them with students
- Lead or arrange for field trips or guest speakers
- Stimulate and guide independent research
- Show students practical applications of computers in science
- Serve as a resource person for you or your students
- Help obtain, fix, and maintain equipment
- Serve as tutors, mentors, and role models for individuals or small groups
- Encourage female and minority students to enter science-oriented careers
- Work with parents and families
- Lead after-school science and math clubs
- Assist with science, math, and career festivals

and more—be creative!

"Thank you so much for visiting our class. The kids (and I) learned a lot about Marine Biology and Diving. Last week in Reading Class we were studying "Diagrams" and we had a practice paper with a diagram of "diving gear." I was pleased to see how much of the equipment the kids still recognized! Thank you, especially, for giving the kids a chance to see that scientists can be "real people". I am not sure that is something I realized at their age. P.S. You can see from the kid's letters what an impression your visit made upon them."

—Bonnie Farb, 5th grade teacher

"One thing I try to get across is that you don't have to have a Ph.D. to contribute in science."

—Melissa Mar, Research Biologist

"I discussed the role of fungi in our lives and displayed examples of fruiting bodies and culture plates. The students displayed a great deal of interest and asked both interesting and stimulating questions. The teacher showed an extremely high degree of interest and enthusiasm that seemed to transfer to students. I found the experience to be rewarding beyond my expectations."

—Dr. John E. Mayfield, Mycologist

"I liked when you put the blue and orange compounds together in the liquids. Please say hello to Dr. Hegley, and doctor Pinhas for me. Your friend, Dennis (the person who wants to find out the chemical reaction)."

—5th Grade Student

"I talked about entomology, showed the students a collection of unusual insects, allow the students to handle some live insects, and gave each of them caterpillars and supplies to rear them to adults. The students were interested and excited. Meeting with a scientist enhanced the students' perception that science is a real activity and occupation, and not just a school subject."

—M. Scott Thomson

"I showed the separation of dyes in grape soft drink as a way of illustrating separations and their utility in analyzing for pollutants. Students reacted with enthusiasm and suggested other separations to try. I hope students learned that scientists are real people and that science can be fun."

—Douglas E. Rickert

"A scientist helped a second-grade class make electromagnets from materials no more complex than a battery, a nail, and a length of wire. With fumbling fingers, the students created their apparatus and then proceeded, without foreknowledge, to see what the contraption would do. Thrilled with herself and her creation, one bright-eyed girl cried out, "I made a magnet! I did it! I really made a magnet!" Relating his experience, the scientist grew wistful. "It was that experience," he said, "that reminded me of why I am doing all this. Now I know my efforts are worth something."

—Colorado Alliance for Science

You're Not In This Alone!

Science education is a national priority. Thousands of scientists are interested in volunteering. *Sharing Science With Children: A Survival Guide for Scientists and Engineers*, a companion to this publication, is in the hands of tens of thousands of scientists. Many national organizations have committed to improving science learning.

The National Science Foundation (NSF) has designated the last week of April each year as National Science & Technology Week. NSF encourages teachers, scientists, and others to participate through school activities, community projects, and public lectures.

Science centers provide rich experiences in science. They are a resource for science activities and ideas for teaching science. Their national organization, **The Association of Science-Technology Centers** (ASTC) is promoting partnerships between teachers, museums, and scientists. Contact your local science center to learn what is available in your community.

The American Association for the Advancement of Science (AAAS), a national organization of 130,000 scientists, actively encourages member scientists to work with teachers in schools. Their publication, *Sourcebook for Science, Mathematics & Technology Education*, includes more than 2,000 listings of programs, people, projects, publications, and organizations. It can be ordered by writing: AAAS, 1333 H Street, Washington, DC 20005.

The Colorado Alliance For Science sponsors a Visiting Scientists Program. For information on this program call (303) 556-4740. The Alliance has 14 regional offices and branches throughout Colorado. For phone numbers and addresses, call the headquarters in Boulder at (303) 492-6392.

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